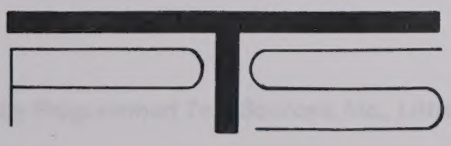
DM-1000

SECTION



PROGRAMMED TEST SOURCES, inc.

Littleton, Massachusetts, USA.

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INTRODUCTION

The DM-1000 is used repetitively, up to seven times per instrument, to synthesize, according to external command, all digits from the 0.1 Hz to the 100 KHz step. The actual number of DMs used is dependent on the resolution option (smallest frequency step) of the synthesizer: For 0.1 Hz steps seven DMs are needed; for reduced resolution the number decreases by one DM for each digit.

All DMs in the instrument operate in series; each module restores the signal to a normal output level independent of the level of input signals above a threshold. Although all DMs are identical and produce at their output 100 KHz steps, these steps are reduced to the proper significance by the repeated division in the chain. The module combines analog, VHF and digital techniques. It is programmed through four parallel lines in BCD. All inputs and outputs are fed through card-edge connectors with multiple low-inductance grounds provided for the RF signals. All DM-1000s are interchangeable; however, they are not interchangeable with the DMA-1005 or any other module in the synthesizer.

The digit module is of plug-in design and uses three ten-pin connectors with asymmetric spacing assuring proper orientation; it is secured with three 6-32 screws from the bottom of the deck. Housed in a frame and U-cover enclosure, the DM-1000 can be removed as a complete unit after releasing the 6-32 pan-head screws. The printed-circuit board may also be removed separately from the enclosure, after the four cover screws (4-40) on top have been released and the cover has been lifted off. Holes near the top corners of the board facilitate prying the board up and free of the connectors by using a small tool alternately on both sides.

PRINCIPLES OF OPERATION

The block diagram of Figure 1 shows a series-string of DM modules, which produce digit steps in a PTS synthesizer. The direction of signal flow in this string of modules is from the least significant to the most significant digit. The input to the first DM in the chain is 14.000 MHz from the 14 MHz bus in the deck; as the frequency is processed, it always remains between 14 and 15 MHz passing from one DM to the next.

The DM module has the following arithmetic capabilities: When receiving a frequency of 14.xyz . . . MHz from the predecessor, it will produce an output frequency of 14.axyz . . . MHz, where "a" directly corresponds to the dial setting (digit control) of the module. In other words, all digits behind the decimal point are moved to the right by one position (reduced in significance by ten), and a new 100 KHz step, as selected by the digit control (manual or remote), is placed ahead of the received digits.

The block diagram of Figure 2 shows the DM-1000 module. Apart from the input and output, the module is connected to the following fixed bus frequencies: 112 MHz, 113 MHz, 14, 16, 18, 20, 22 MHz, which are all crystal-oscillator-derived and coherent. For any one digit selection, the DM uses either 112 or 113 MHz and one of the five lower frequencies. 112 or 113 MHz is used to make even or odd digits; 14 MHz is used with digits 0,1; 16 MHz with digits 2,3; 18 MHz with digits 4,5, and so on.

To illustrate the operation, the block diagram (Figure 2) shows as a sample all frequencies which are internally produced in a DM, if it receives an input of 14.210 MHz and is set to digit "3". With the aid of the schematic of Figure 3, the circuitry used to effect the arithmetic may be traced.

14.210 MHz as received on pin 3 is fed to the base of Q10, an additive mixer. Digit control pins 5 and 6 (weight 1 and 2) are "high" if a "3" is selected, and decoder-ICs U1 and U2 furnish two DC outputs: "3" being odd, Q2, the 113

MHz switch, is turned on; and, since "3" belongs to the second pair of ten frequencies (2,3), Q5, which controls 16 MHz, is turned on.

113 MHz reaches the base of Q10 via C28. The upper sideband (sum) of the two inputs to Q10, 14.210 MHz and 113 MHz, is 127.210 MHz. Two double-tuned filters and amplifier Q11, which have a passband of 126-128 MHz, deliver this frequency to the input of the second mixer Q8/Q9.

T1 is connected to the output of switch-transistors Q3 to Q7, and, since Q5 is turned on, 16 MHz is the other input to the second mixer. Again, the circuits following are tuned to select the upper sideband, which is between 140 and 150 MHz. Our specific sample signal is 127.210 MHz plus 16 MHz, or 143.210 MHz. The filters suppress the lower sideband and other unwanted products. After amplification, the signal reaches U3, which is a digital divide-by-ten IC. The output is filtered by a tuned circuit, and a signal of 14.3210 MHz is fed to pin 50. As we see, a "3" has been placed ahead of "210", and the latter digits have moved one position to the right. In this fashion, a multi-digit number is synthesized.

MODULE SPECIFICATIONS

Inputs:	14 - 15 MHz	0.20 - 0.35V
	112, 113 MHz	0.10 - 0.17V
	14,16,18,20,22 MHz	90 - 125 mV
Output:	14 - 15 MHz	0.25 - 0.31V nominal
		0.20V minimum
		Load: 1.3 KΩ parallel 30 pF
Programming:	1,2,4,8 BCD, positive true	
	High: 3.0V minimum	Low: 0.5V maximum
Spurious Outputs:	-75 dB	
Power:	+5.4V, 100 mA ±10%	-12.4V, 38 mA ±10%
Operating Temp:	0 - 60°C	

SERVICE

Maintenance

No preventive maintenance is required for DM modules. The presence of an output signal of correct frequency and level indicates that the module is operating properly. The output of the module is produced directly by an IC divider. A 10 dB window exists at the divider input, and minor aging effects will, therefore, not impair operation.

Replacement of faulty components requires careful use of printed-circuit repair techniques as applicable to double-sided boards with plated-through holes.

Alignment

Complete alignment of this module is made at the factory with a special test-set. Restoring the alignment after replacement of individual parts in the field is possible. It is recommended that voltages given in the Troubleshooting Procedure be used and that, in general, touch-up alignment be performed only on those tuned circuits which may have been altered by the parts replacements. Replacement of semiconductors will not necessitate realignment of tuned circuits in general.

Troubleshooting Procedure

The System Section of this manual provides information to isolate faulty modules. It is important to follow the procedure given in detail to ensure that all the common supply frequencies are present before attempting to repair modules.

If a DM module has been isolated as faulty, the preferred service mode is exchange and factory repair. When immediate service is needed, the following procedure may be used.

Test Equipment Required:

RF Voltmeter	1 - 300 MHz, 10 mV - 1V, High Impedance Probe (3 pF, DC Res 100 KΩ)
HF Counter	0 - 200 MHz, 10 mV Sensitivity, High Impedance or 50 Ω Input

The output of the DM module is on pin 50, which is also the test point designation used in the System Section and the running number of the board-edge connector as shown on the schematic (Figure 3). The module produces 14.000 MHz at a level of 0.2 - 0.35V into the next DM module if all instrument dials have been set to zero. As the dial of the module under test is changed through successive numbers 0 to 9, the output frequency should change in 100 KHz steps from 14.000 MHz to 14.900 MHz. If the output is of the proper frequency but low in level, the output tank L10/C62 or the tuning should be checked. C62 is peaked at a setting of 5 (14.500 MHz). Only the voltmeter probe must remain connected to pin 50 for final tuning.

Absence of output for some dial settings points to specific causes:

1. No output on *two* successive even-odd digits (e.g., 2,3) indicates that the second mixer, Q8, Q9 does not receive one of the low bus frequencies from 14 to 22 MHz, and the fault is likely located in the switch section (Q3 to Q7). 14 MHz is used for digit 0,1; 16 MHz for digit 2,3, and so on.

2. No output on either *all odd* or *all even* digits will result from failure in the 112/113 MHz switches Q1 or Q2, since 112 MHz is used to produce all even digits and 113 MHz to make the odd digits.

3. If no output is obtained on any digit, if random digits are missing, or if an unsteady counter reading (noise) is present, the divider (U3) is

faulty or the input on pin 7 is low. 0.2V minimum is to be read at this point with only the voltmeter connected. If the above checks (1 and 2) were positive, then part of the circuitry that is used on all digits must be faulty. The active devices are Q10, Q11, Q8, Q9 and Q12. DC operating conditions on all of these transistors are such that 1.1 to 1.5V should be measured across their emitter resistors R40, R45, R34 and R48.

RF voltages at various stages are given to permit further localization of the trouble. The previously indicated level of 0.2V into pin 7 of the divider is a minimum; other voltages may differ from normal by ±3 dB.

Base Q10	0.10V
Base Q11	0.05V
C23/C24	0.50V
Base Q12	0.07V
U3, Pin 7	0.28V

The 126-128 MHz signal at C23/C24 peaks at digit setting "5" and drops approximately 2 dB for settings "0" and "9" on the preceding DM module (less significant digit). Voltage at pin 7 of U3 responds to digit settings on the DM under test, and the minimum voltage must be obtained for all settings.

PARTS LIST

Schem. Desig.	Description	PTS P/N
	CAPACITORS	
C1	1 nF, 10%, 500V, X5F	22-0102
C2	220 pF, 10%, 500V, X5F	22-0221
C3	50 nF, 80/20%, 50V, Z5V	23-0503
C4	1 nF, 10%, 500V, X5F	22-0102
C5	1 nF, 10%, 500V, X5F	22-0102
C6	50 nF, 80/20%, 50V, Z5V	23-0503
C7	50 nF, 80/20%, 50V, Z5V	23-0503
C8	220 pF, 10%, 500V, X5F	22-0221
C9	1 nF, 10%, 500V, X5F	22-0102
C10	1 nF, 10%, 500V, X5F	22-0102
C11	1 nF, 10%, 500V, X5F	22-0102
C12	1 nF, 10%, 500V, X5F	22-0102
C13	1 nF, 10%, 500V, X5F	22-0102
C14	1 nF, 10%, 500V, X5F	22-0102
C15	1 nF, 10%, 500V, X5F	22-0102
C16	1 nF, 10%, 500V, X5F	22-0102
C17	220 pF, 10%, 500V, X5F	22-0221
C18	220 pF, 10%, 500V, X5F	22-0221
C19	220 pF, 10%, 500V, X5F	22-0221
C20	220 pF, 10%, 500V, X5F	22-0221
C21	220 pF, 10%, 500V, X5F	22-0221
C22	68 pF, 5%, 500V, N750	21-0680
C23	22 pF, 5%, 500V, NPO	20-0220
C24	22 pF, 5%, 500V, NPO	20-0220
C25	10 nF, 80/20%, 50V, Z5V	23-0103
C26	27 pF, 5%, 500V, NPO	20-0270
C27	1-10 pF, Trimmer	26-5100
C28	5 pF, .25 pF, 500V, NPO	20-1500
C29	10 nF, 80/20%, 50V, Z5V	23-0103
C30	10 nF, 80/20%, 50V, Z5V	23-0103
C31	47 pF, 5%, 500V, NPO	20-0470
C32	22 pF, 5%, 500V, NPO	20-0220
C33	1-10 pF, Trimmer	26-5100
C34	0.68 pF, .25 pF, 500V, NPO	24-2680
C35	22 pF, 5%, 500V, NPO	20-0220
C36	1-10 pF, Trimmer	26-5100
C37	5 pF, .25%, 500V, NPO	20-1500
C38	5 pF, .25 pF, 500V, NPO	20-1500
C39	10 nF, 80/20%, 50V, Z5V	23-0103

PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
	CAPACITORS (continued)	
C40	10 nF, 80/20%, 50V, Z5V	23-0103
C41	22 pF, 5%, 500V, NPO	20-0220
C42	1-10 pF, Trimmer	26-5100
C43	0.68 pF, .25 pF, 500V, NPO	24-2680
C44	1-10 pF, Trimmer	26-5100
C45	22 pF, 5%, 500V, NPO	20-0220
C46	15 pF, 5%, 500V, NPO	20-0150
C47	1-10 pF, Trimmer	26-5100
C48	3.3 pF, 5%, 500V, NPO	20-1330
C49	10 pF, 5%, 500V, NPO	20-0100
C50	1-10 pF, Trimmer	26-5100
C51	5 pF, .25 pF, 500V, NPO	20-1500
C52	10 nF, 80/20%, 50V, Z5V	23-0103
C53	10 nF, 80/20%, 50V, Z5V	23-0103
C54	10 pF, 5%, 500V, NPO	20-0100
C55	1-10 pF, Trimmer	26-5100
C56	2.2 pF, .25 pF, 500V, NPO	20-1220
C57	10 pF, 5%, 500V, NPO	20-0100
C58	1-10 pF, Trimmer	26-5100
C59	10 pF, 5%, 500V, NPO	20-0100
C60	50 nF, 80/20%, 50V, Z5V	23-0503
C61	10 pF, 5%, 500V, NPO	20-0100
C62	1-10 pF, Trimmer	26-5100
C63	10 pF, 5%, 500V, NPO	20-0100
C64	68 pF, 5%, 500V, N750	21-0680
	INDUCTORS	
L1	50 nH, nom.	35-5100
L2	50 nH, nom.	35-5100
L3	50 nH, nom.	35-5100
L4	50 nH, nom.	35-5100
L5	50 nH, nom.	35-5100
L6	50 nH, nom.	35-5100
L7	50 nH, nom.	35-5100
L8	50 nH, nom.	35-5100
L9	50 nH, nom.	35-5100
L10	5.6 μH, 20%	36-5100

PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
	RESISTORS	
R1	10 KΩ, 5%, ¼W	10-0103
R2	2.2 KΩ, 5%, ¼W	10-0222
R3	15 Ω, 5%, ¼W	10-0150
R4	680 Ω, 5%, ¼W	10-0681
R5	47 Ω, 5%, ¼W	10-0470
R6	1 KΩ, 5%, ¼W	10-0102
R7	10 KΩ, 5%, ¼W	10-0103
R8	15 Ω, 5%, ¼W	10-0150
R9	680 Ω, 5%, ¼W	10-0681
R10	2.2 KΩ, 5%, ¼W	10-0222
R11	1 KΩ, 5%, ¼W	10-0102
R12	47 Ω, 5%, ¼W	10-0470
R13	47 Ω, 5%, ¼W	10-0470
R14	680 Ω, 5%, ¼W	10-0681
R15	10 KΩ, 5%, ¼W	10-0103
R16	2.2 KΩ, 5%, ¼W	10-0222
R17	1.5 KΩ, 5%, ¼W	10-0152
R18	1.5 KΩ, 5%, ¼W	10-0152
R19	1.5 KΩ, 5%, ¼W	10-0152
R20	1.5 KΩ, 5%, ¼W	10-0152
R21	1.5 KΩ, 5%, ¼W	10-0152
R22	1 KΩ, 5%, ¼W	10-0102
R23	1 KΩ, 5%, ¼W	10-0102
R24	1 KΩ, 5%, ¼W	10-0102
R25	1 KΩ, 5%, ¼W	10-0102
R26	1 KΩ, 5%, ¼W	10-0102
R27	330 Ω, 5%, ¼W	10-0331
R28	330 Ω, 5%, ¼W	10-0331
R29	330 Ω, 5%, ¼W	10-0331
R30	330 Ω, 5%, ¼W	10-0331
R31	330 Ω, 5%, ¼W	10-0331
R32	47 Ω, 5%, ¼W	10-0470
R33	6.8 KΩ, 5%, ¼W	10-0682
R34	220 Ω, 5%, ¼W	10-0221
R35	1.5 KΩ, 5%, ¼W	10-0152
R36	15 Ω, 5%, ¼W	10-0150
R37	680 Ω, 5%, ¼W	10-0681
R38	1.5 KΩ, 5%, ¼W	10-0152

PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
	RESISTORS (continued)	
R39	6.8 KΩ, 5%, ¼W	10-0682
R40	330 Ω, 5%, ¼W	10-0331
R41	Not Used	-----
R42	6.8 KΩ, 5%, ¼W	10-0682
R43	1.5 KΩ, 5%, ¼W	10-0152
R44	15 Ω, 5%, ¼W	10-0150
R45	150 Ω, 5%, ¼W	10-0151
R46	6.8 KΩ, 5%, ¼W	10-0682
R47	1.5 KΩ, 5%, ¼W	10-0152
R48	150 Ω, 5%, ¼W	10-0151
R49	4.7 Ω, 5%, ¼W	10-1470
R50	2.2 KΩ, 5%, ¼W	11-0222
R51	4.7 Ω, 5%, ¼W	10-1470
R52	680 Ω, 5%, ¼W	11-0681
R53	470 Ω, 5%, ¼W	10-0471
R54	470 Ω, 5%, ¼W	10-0471
R55	15 Ω, 5%, ¼W	10-0150
R56	15 Ω, 5%, ¼W	10-0150
R57	15 Ω, 5%, ¼W	10-0150
R58	2.2 KΩ, 5%, ¼W	10-0222
R59	100 Ω, 5%, ¼W	10-0101
R60	100 Ω, 5%, ¼W	10-0101
R61	100 Ω, 5%, ¼W	10-0101
R62	1.0 KΩ, 5%, ¼W	10-0102
R63	470 Ω, 5%, ¼W	10-0471

Note: 10-xxxx carbon composition
11-xxxx carbon film

	TRANSISTORS	
Q1	2N 3250	41-3250
Q2	2N 3250	41-3250
Q3	2N 3250	41-3250
Q4	2N 3250	41-3250
Q5	2N 3250	41-3250
Q6	2N 3250	41-3250
Q7	2N 3250	41-3250
Q8	2N 2369	40-2369

PARTS LIST (continued)

Schem. Desig.	Description	PTS P/N
	TRANSISTORS (continued)	
Q9	2N 2369	40-2369
Q10	2N 2369	40-2369
Q11	2N 5179	40-5179
Q12	2N 5179	40-5179
	TRANSFORMERS	
T1	Transformer, RF	84-5100
	DIODES	
CR1	BA 244	71-0244
CR2	BA 244	71-0244
CR3	BA 244	71-0244
CR4	BA 244	71-0244
CR5	BA 244	71-0244
CR6	BA 244	71-0244
	INTEGRATED CIRCUITS	
U1	74L20	61-5101
U2	74L00	61-5100
U3	MC10138	62-5100

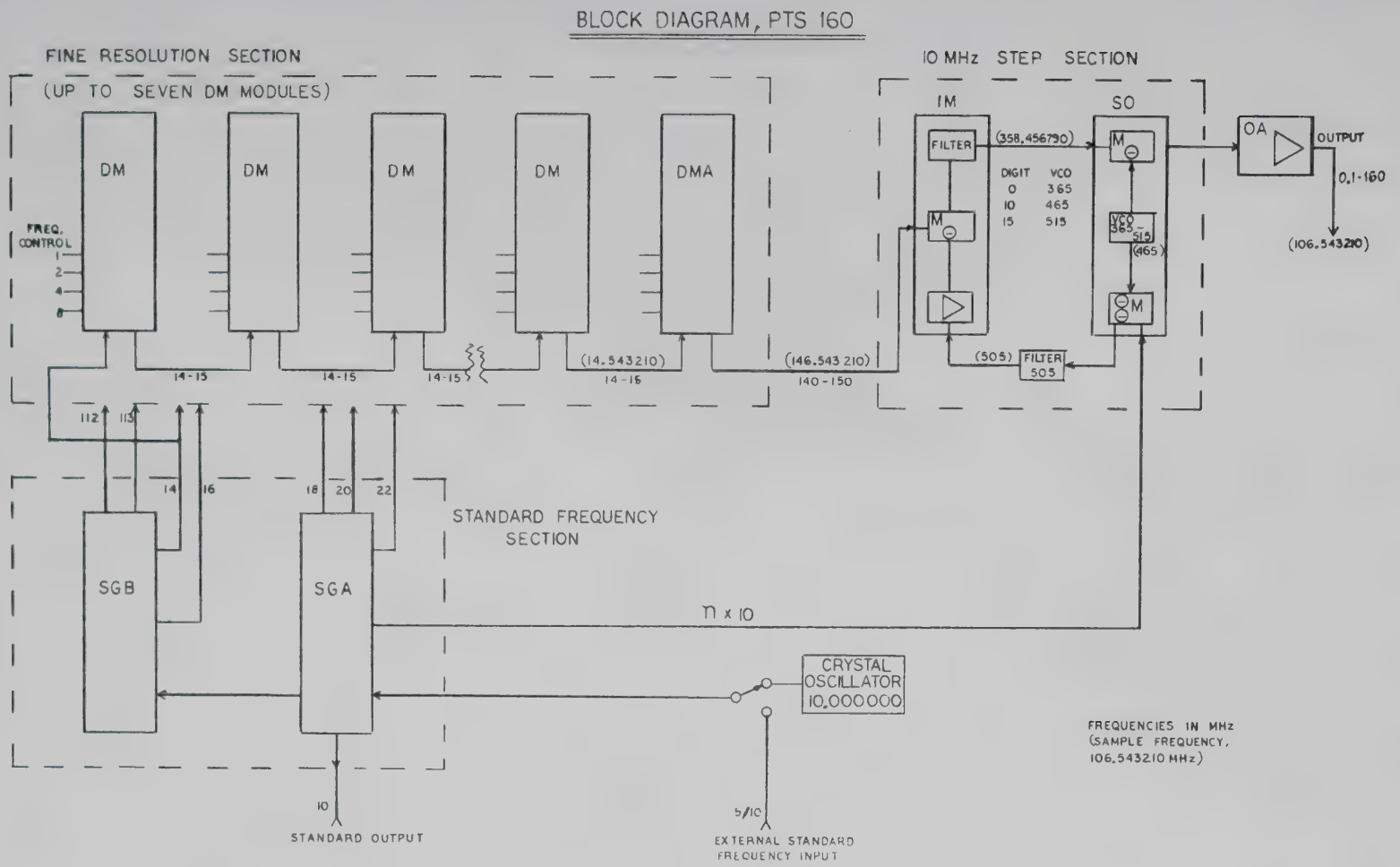
BLOCK DIAGRAM, PTS 160
FINE RESOLUTION SECTION
(UP TO SEVEN DM MODULES)
10 MHz STEP SECTION
DM
DM
DM
DM
DMA
FREQ. CONTROL
1
2
4
8
14-15
14-15
14-15
(14.543210)
14-16
(146.543210)
140-150
IM
SO
FILTER
(358.456790)
DIGIT VCO
0 365
10 465
15 515
VCO 365-515
(465)
OA
OUTPUT
0.1-160
(106.543210)
(505)
FILTER 505
112
113
14
16
18
20
22
STANDARD FREQUENCY SECTION
SGB
SGA
n x 10
CRYSTAL OSCILLATOR 10.000000
FREQUENCIES IN MHz
(SAMPLE FREQUENCY, 106.543210 MHz)
10
STANDARD OUTPUT
5/10
EXTERNAL STANDARD FREQUENCY INPUT

Figure 1

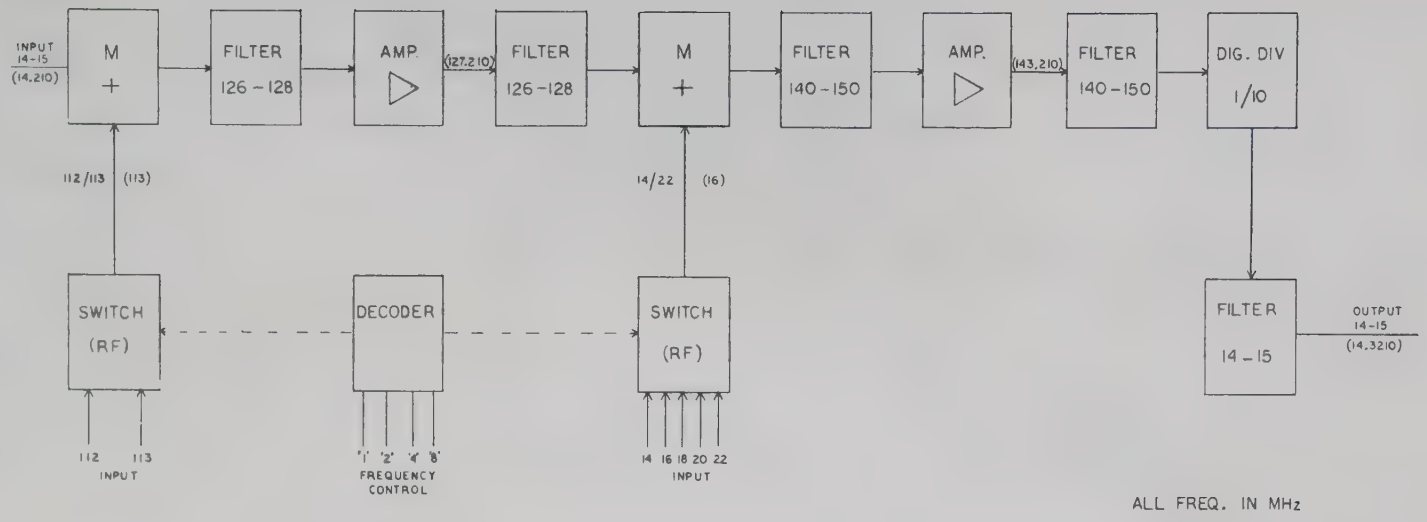
INPUT
14-15
(14.210)
M
+
FILTER
126 - 128
AMP.
(127.210)
FILTER
126 - 128
M
+
FILTER
140 - 150
AMP.
(143.210)
FILTER
140 - 150
DIG. DIV
1/10
112/113
(113)
14/22
(16)
SWITCH
(RF)
DECODER
SWITCH
(RF)
FILTER
14 - 15
OUTPUT
14-15
(14.3210)
112
113
INPUT
'1' '2' '4' '8'
FREQUENCY
CONTROL
14 16 18 20 22
INPUT
ALL FREQ. IN MHz

Figure 2

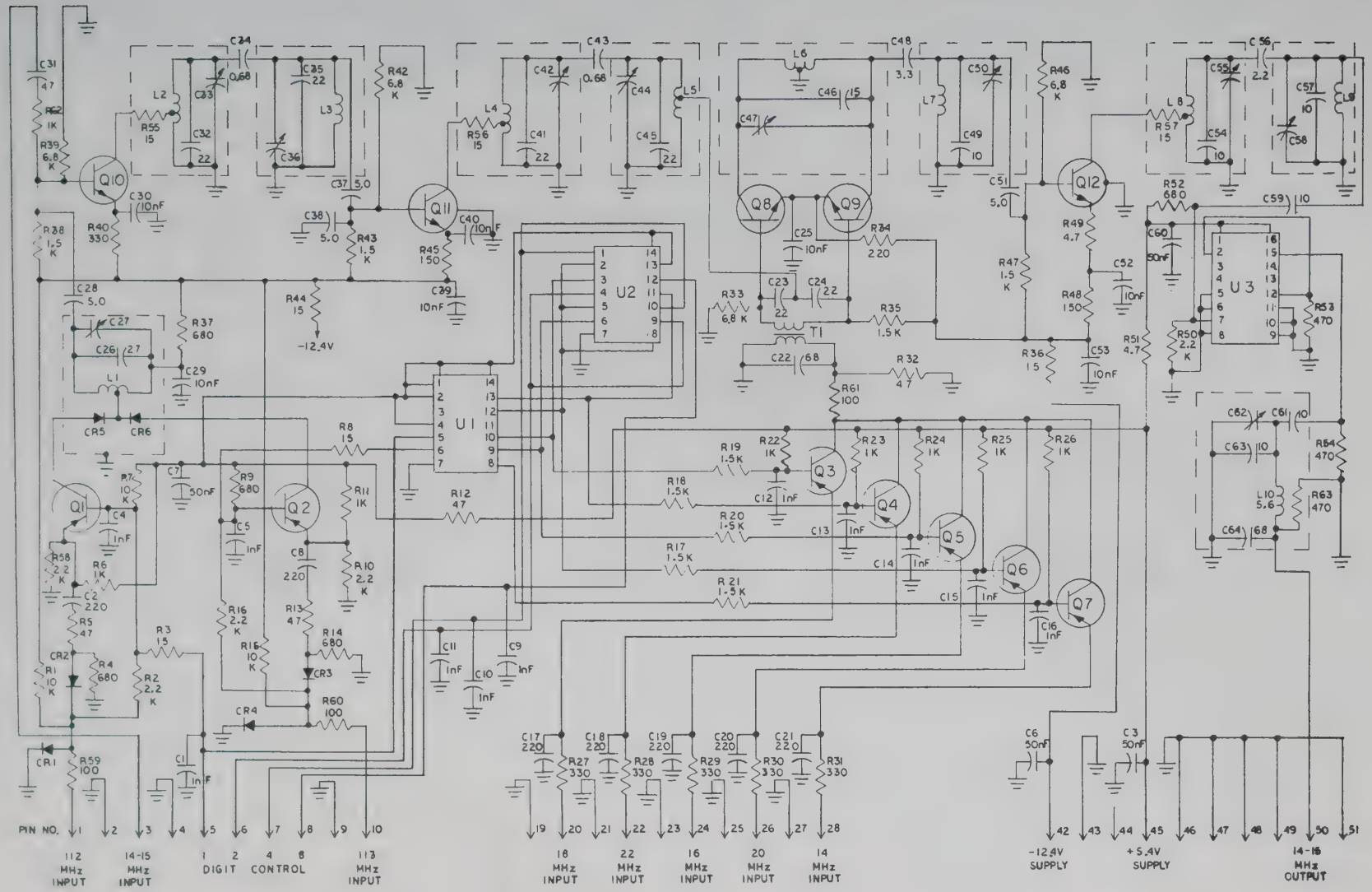
PIN NO.
112 MHz INPUT
14-15 MHz INPUT
1 2 4 8 DIGIT CONTROL
113 MHz INPUT
18 MHz INPUT
22 MHz INPUT
16 MHz INPUT
20 MHz INPUT
14 MHz INPUT
-12.4V SUPPLY
+5.4V SUPPLY
14-16 MHz OUTPUT
U1
U2
U3
T1
-12.4V

Figure 3

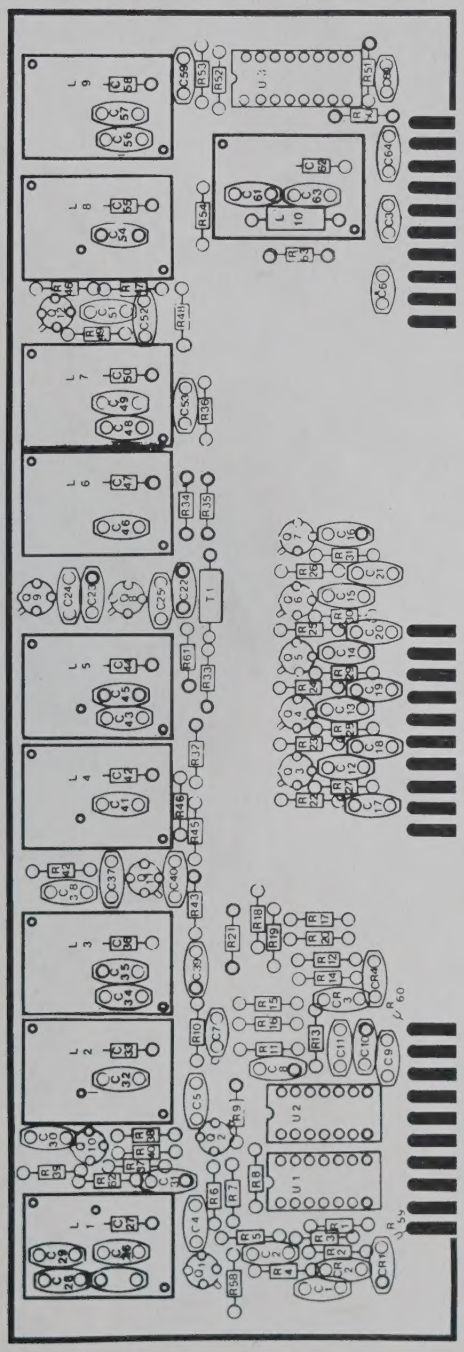

Figure 4